ACC NR: AT6028370

are mainly caused by compression and expansion of the mantle associated with polymorphic, phase and electron transformations, or chemical alterations. Deep-seated faults originate in the upper mantle hundreds or at least tens of km deep. The main types of faults located in the Ukraine are: 1) ancient Proterozoic faults in the Precambrian basement; 2) faults of different ages, expressed in the basement as major stages and separating principal structural features or their components; and 3) transverse (sometimes longitudinal) faults cutting across the main structures and separating them into individual blocks. In addition, there are many faults in the sedimentary strata which are directly or indirectly associated with the block movement of the basement. The study of the deep-seated crustal structure of the main geotectonic features of the Ukraine is based upon geophysical, mostly seismic, investigations. The block-type structure of the crust has been established, and a number of deep-seated faults have been located. A general feature is increased crustal thickness under uplifts and decreased thickness under depressions. It has been found that the granite layer contains shallow gently sloping seismic discontinuities, which may either separate different structural stages and rock complexes or represent purely physical boundaries. The Ukraine has been divided into structural zones on the basis of geological and geophysical data, and detailed characteristics of all zones are given. Orig. art. has: 2 figures.

SUB CODE: 08/ SUBM DATE: 06Jan65/ ORIG REF: 025/ OTH REF: 006/

Card 2/2

ACC NR: AR6024835 SOURCE CODE: UR/0169/66/000/004/G003/G003

AUTHOR: Subbotin, S. I.; Gurevich, B. L.; Kuzhelov, T. K.; Sollogub, V. B.; Chekunov, A. V.; Chirvinskaya, M. V.

TITLE: The plutonic formation on the territory of the Ukrainian SSR according to data from a geophysical study

SOURCE: Ref. zh. Geofizika, Abs. 4G13

REF SOURCE: Sb. Geol. rezul'taty prikl. geofiz. Geofiz. issled. stroyeniya zemn. kory. M., Nedra, 1965, 56-59

TOPIC TAGS: geological survey, area description, geomagnetic field

ABSTRACT: The main relationship between the anomalous gravitational field and the geological structure of the territory in question is the linearity of the field in the regions of deep submersion of the Precambrian foundation and the mossaic-like arrangement of the shallow surface Precambrian bed. The geomagnetic field anomlies mainly reflect the internal structure of the Precambrian foundation, i.e., Proterozoic folded linear regions and prehistoric plutonic localized objects of the basic and ultrabasic rock. In the regions where large subcambrian deposits were formed the geomagnetic field anomalies mainly reflect the presence of shallow effusive bedrock. A large number of plutonic breaks and "feathered" cracks were established from the data of seismometry, gravimetry, and by other geophysical methods. The thickness of the

 UDC: 550.311(477)

KOROTKOV, Sergey Nikitich; KRAVCHENKO, Semen Moiseyevich; SUBBOTIN, Semen Semenovich; BORISOVA, G.A., red.; BRODSKIY, M.P., tekhn. red.

[Manufacture of custom-made outerwear]Izgotovlenie verkhnei odezhdy po individual'nym zakazam. Moskva, Gostorgizdat, 1963. 301 p. (MIRA 16:4)

(Tailoring)

L 15566-63 EPR/EPA(b)/BDS AFFTC/ASD Pc-4/Pi-4 EM/WW

ACCESSION NR: AP3002804 S/0207/63/000/003/0045/0048

AUTHORS: Mitrofanov, V. V.; Subbotin, V. A.; Topchiyan, M. E. (Novosibirsk) 65 64

TITLE: Measurement of pressure in a spinning transverse wave

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 3, 1963, 45-48

TOPIC TAGS: detonation, gas dynamics, pressure, experiment

ABSTRACT: As is known, detonation mixtures near the ends of ducts go into a spin mechanism. At the front a transverse wave is formed which turns in a neighborhood along the wall of the duct. Computations show that (in the transverse wave) the maximal pressure is 170-180 times greater than the initial pressure of the mixture, i.e., 10 times greater than at the Chepmen-Zhuge point for detonation waves on the whole. V. V. Mitrofanov (Struktura detonatsionnoy volny v ploskom kanale. PMTF, 1962, No. 4) gave results of measuring the field of pressure in a spinning wave (using small piezo-transmitters) which agreed well with the computational measurements. However, because of the lack of tare of the transmitters in absolute value of the pressures and the extreme pressure of the oscillograms along the time axis, these measurements could not be considered sufficiently reliable. The authors repeated the tests more carefully and state the results

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L 15566-63

ACCESSION NR: AP3002804

obtained. All of the oscillograms in the tests described in the article were repeated many times. Therefore, the flow scheme in the spinning wave given by the authors listed in the bibliography can be considered definitely confirmed. "The authors are grateful to S. V. Voytsekhovskiy for his attention to this work." Orig. art. has: 4 figures.

ASSOCIATION: none

SUBMITTED: 01Feb63 DATE ACQ: 16Jul63 ENCL: 00

SUB CODE: PH, FL NO REF SOV: 008 OTHER: 000

Card 2/2

KOROTKOV, Sergey Nikitich; SUBBOTIN, Semen Semenovich; GOLOVANOV, V.V., red.; BUNICHEV, P.Ye., polkovnik, tekhn.red.; SRIBNIS, N.V., tekhn.red.

[Designing and tailoring military uniforms; textbook] Konstruirovanie voennoi odezhdy; uchebnoe posobie. Moskva, Voen.izd-vo M-va obor.SSSR, 1960. 335 p. (MIRA 13:11)
(Uniforms, Military)

SUBBOTIN, S.V.

Subbotin, S. V.

"The problem of using in concrete sand containing large quantities of loess impurities." Acad Sci Uzbek SSR. Inst of Structure. Tashkent, 1956. (Dessertation for the Technical Sciences).

Knizhnaya letopis'
No. 21, 1956. Moscow.

SUBBOTIN, S.V., kand.tekhn.nauk; ZHUKOV, N.V., inzh.

New method of testing the tensile strength of concrete. Transp. stroi. 9 no.2:52-54 F '59. (MIRA 12:5)
(Concrete--Testing)

TYURIN, S.T.; SUBBOTIN, V.A.

Methods for determining wine losses in evaporation, absorption and wetting. Trudy VNIIViV "Magarach" 13:164-172 '64.

(MIRA 17:12)

SKOROKHODOV, N.Ya.; SUBBOTIN, V.A.

Investigating the efficiency of sectional rolls. Izv. vys. ucheb. zav.; chern. met. 8 no.10:84-89 '65. (MIRA 18:9)

1. Magnitogorskiy gornometallurgicheskiy institut.

SUBBOTIN, V. A.

"K voprosu o zemel'nykh otnosheniyakh v Futa-Dzhallone nakanune kolonizatsii."

report submitted for 7th Intl Cong, Anthropological & Ethnological Sciences, Moscow, 3-10 Aug 64.

L 20779-66 EWP(k)/EWT(d)/EWT(m)/EWP(h)/EWP(l)/EWP(v)/EWP(t) HW/JD

ACC NR: AP6005559 SOURCE CODE: UR/0148/65/000/010/0084/0089

AUTHOR: Skorokhodov, N. Ye; Subbotin, V. A. 30 B

ORG: Magnitogorsk Mining and Metallurgy Institute (Magnitogorskiy gornometallurgicheskiy institut)

TITLE: Study of the performance of composite rolling-mill rolls 14

SOURCE: IVUZ. Chernaya metallurgiya, no. 10, 1965, 84-89

TOPIC TAGS: composite roll, rolling mill, cold rolling, hot rolling

ABSTRACT: It is shown that the working surface of rolling-mill rolls can be easily renewed and roll changing eliminated by using rolls of the composite type, consisting of a fixed central core surrounded by two semi-cylinders that are fitted together. Rolls of this kind (Fig. 1), have been experimentally used for 10 months in the cold rolling of lead, aluminum, and copper and in the cold and hot rolling of low-carbon steel. It was thus established that the fastening of the semi-cylinders to the steel core of the roll is sufficiently strong and reliable even under conditions of extra-high loading. This new design dispenses with the need for roll changing, since now the roll core is a permanent part of the rolling stand and only the semi-cylinder need be replaced. The new design is suitable for both smooth and grooved rolls. This was also confirmed by laboratory tests on models of two- and

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L 20779-66

ACC NR: AP6005559

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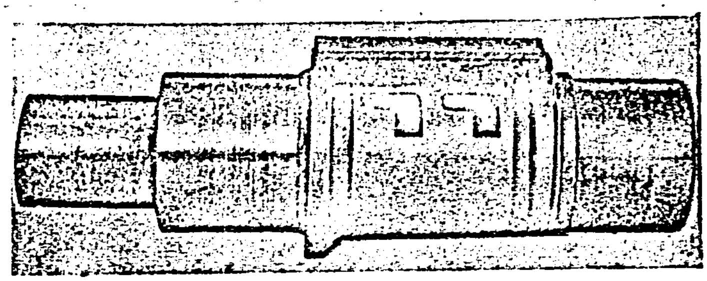

Fig. 1. Composite roll with lengthwise-split barrel (one semi-cylinder removed)

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L 20779-66

ACC NR: AP6005559

four-high mills, and by the concomitant analysis of rolling kinograms. On entry into the area of deformation the gap between the joints of the semi-cylinders decreases owing to the compacting pressure, thus preventing any flowage of metal into the gap. The elimination of roll changing increases the productivity of rolling mills, while the fact that the roll core is now a permanent fixture facilitates the entire technological process and its automation. Orig. art. has: 5 figures.

SUB CODE: 11, 13/ SUBM DATE: 12Apr65/ ORIG REF: 000/ OTH REF: 000

Card 3/3

SUBBOTIN, V.A. (selo Boyarkino, Ozerskiy rayon, Moskovskaya oblast').

Homemade carpenter's and locksmith's bench. Politekh. obuch. no.4: 77-78 Ap '58. (MIRA 11:4)
(Workshops--Equipment and supplies)

ACCESSION NR: AP4033123 S/0120/64/000/002/0109/0111

AUTHOR: Subbotin, V. B.; Yakovlev, V. I.

TITLE: Cold-cathode-tube switch with a wide range of switching speeds

SOURCE: Pribory* i tekhnika eksperimenta, no. 2, 1964, 109-111

TOPIC TAGS: switch, electronic switch, multichannel switch, cold cathode tube, MTKhT-90Ts cold cathode tube

ABSTRACT: A multichannel MTKhT-90Ts-tube switch with an adjustable switching speed of 0-30 kc is briefly described. The switch can provide an unlimited number of outputs with an output-pulse height of over 50 v. Its basic circuit is shown in Fig. 1 of the Enclosure. In connecting the switch to a low-impedance load, a pulse-forming circuit whose circuit diagram is supplied is recommended. Orig. art. has: 3 figures.

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ACCESSION NR: AP4033123

ENCLOSURE: 01

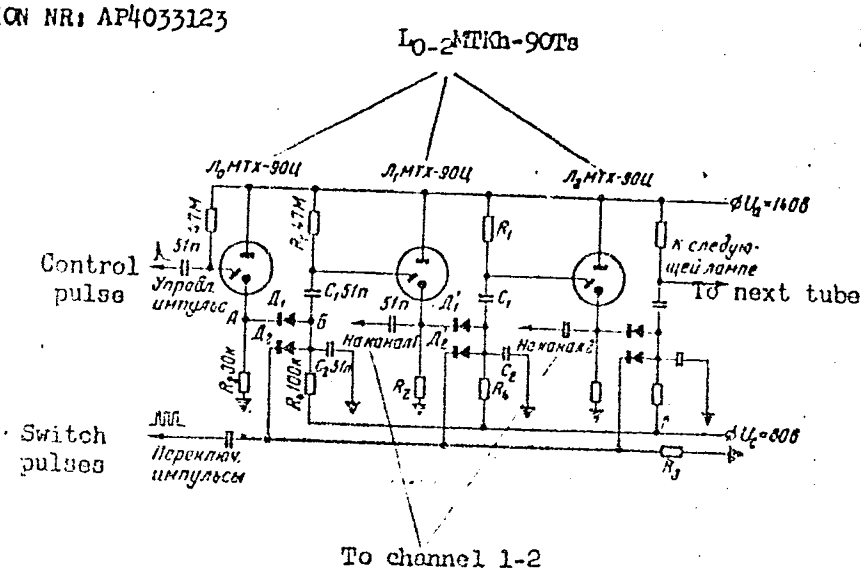


Fig. 1. Cold-cathode-tube high-speed switch

Card 3/3

ACC NR: AP7009584

h(t) is measurable. A theorem and lemma are proven for the connectivity of an integral funnel satisfying the Caratheodory conditions: the functions F (t, u, v), G(t, s, u, v) are measurable with respect to t, (t, s) for every (u, v) and continuous with respect to (u, v) for nearly every t, (t,s). The author thanks M. A. Krasnosel'skiy and Yu. G. Borisovich for discussion of the problems. The author also thanks A. D. Myshkis for observations and advice on the editing work. Orig. art. has: 8 formulas. [JPRS: 40,100]

Card 2/2

POLIKANOV, S.M.; DRUIN, A.V.; KARNAUKHOV, V.A.; MIKHEYEV, V.L.; PLEVE, A.A.; SKOBELEV, N.K.; SUBBOTIN, V.G.; TER-AKOP'YAN, G.M.; FOMICHEV, V.A.

[Spontaneous fission with an anomalously short period] Spontannoe delenie s anomal'no korotkim periodom. Dubna, Ob"edinennyi in-t iadernykh issl. Pt.1. -1662. 17 p. (MIRA 15:1)
(Nuclear fission) 1962.

KARNAUKHOV, V.A.; TER-AKOP'YAN, G.M.; PETROV, L.A.; SUBBOTIN, V.G.

Experimental observation of proton emission in radioactive decay. Zhur. eksp. i teor. fiz. 45 no.4:1280-1282 O '63.
(MIRA 16:11)

1. Ob"yedinennyy institut yadernykh issledovaniy.

KARNAUKHOV, V. A.; TER-AKOP'YAN, G. M.; PETROV, L. A.; SUBBOTIN, V. G.

"Experiments on Observation of Radioactive Decay with the Emission of Protons."

report submitted for All-Union Conf on Nuclear Spectroscopy, Tbilisi, 14-22 Feb 64.

Joint Inst for Nuclear Res, Dubna.

ACCESSION NR: AP4043611 S/0056/64/047/002/0419/0432

AUTHORS: Flerov, G. N.; Karnaukhov, V.A.; Ter-Akop'yan, G. M.; Petrov, L. A.; Subbotin, V. G.

TITLE: On proton decay of radioactive nuclei

SOURCE: Zh. eksper. i teor. fiz., v. 47, no. 2, 1964, 419-432

TOPIC TAGS: radioactive decay, proton decay, proton radiation, heavy particle, Coulomb repulsion force, alpha particle reaction

ABSTRACT: This paper is an elaboration of a previous report (ZhETF v. 45, 1280, 1963) and contains additional new data on observed proton emitters. Experiments on proton decay of radioactive nuclei, using the internal beam of the heavy-ion cyclotron of OIYaI, are described and data are presented on two types of proton emitters obtained by bombarding nickel with beams of $Ne^{20}$ and $O^{16}$. The first (one of the light isotopes of neon or magnesium) has a half-life

ACCESSION NR: AP4043611

$(85 \pm 15) \times 10^{-3}$ sec and emits protons with energy $5 \pm 0.2$ MeV. The second has a half-life $23 \pm 4$ sec and emits protons with energy $2.5 \pm 0.2$ MeV. It is concluded on the basis of several experiments that the second emitter is one of the light isotopes of Kr or Br, so that sub-barrier protons are emitted (height of the Coulomb barrier is $\sim$8.5 MeV). It is most probable that the protons are emitted from the daughter nucleus following the positron transition with which the measured half-life is connected. The emission of $\approx$5 MeV protons is similar to the emission of delayed neutrons. The emission of 2.5-MeV sub-barrier protons is analogous to the emission of long-range alpha particles by heavy nuclei. It is also shown that in the case of the $\approx$2.5-MeV proton emitter another possible mechanism is proton decay of configuration isomers. Further work is planned for an experimental determination of the mechanism of the observed proton decay and for a more exact identification of the obtained protons. "The authors are grateful to E. Z. Ry*ndina and her co-workers for much preparing the silicon detectors, which were

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ACCESSION NR: AP4043611

essentially in the present work. The authors thank V. Titov and V. Chugreyev for construction work, Ye. A. Minin, N. Danilov, and B. Bichev for help in preparation for the experiments, and the cyclotron crew headed by A. N. Filipson for the irradiation." Orig. art. has: 11 figures and 2 tables.

ASSOCIATION: Ob"yedinenny*y institut yaderny*kh issledovaniy (Joint Institute of Nuclear Research)

SUBMITTED: 26Feb64 ENCL: 02

SUB CODE: NP NR REF SOV: 013 OTHER: 013

Card 3/5

ENCLOSURE: 01

ACCESSION NR: AP4043611

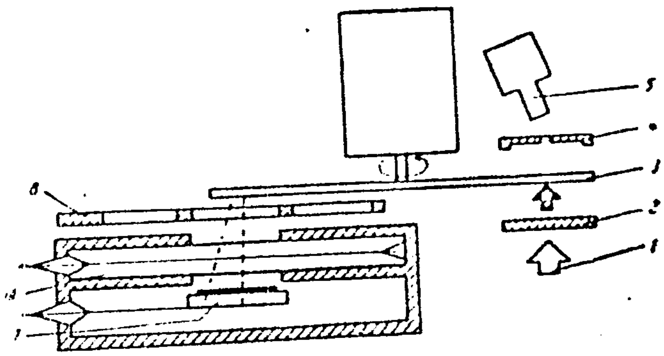
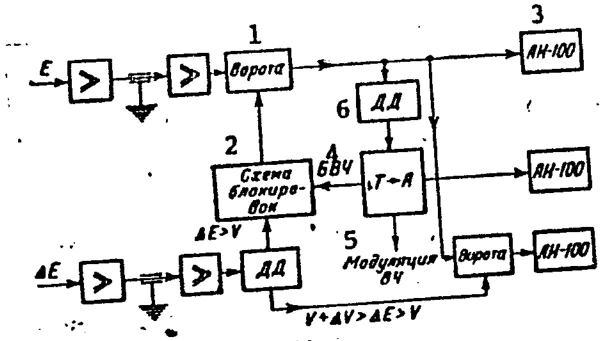



Diagram of experimental set-up
1 - ion beam, 2 - target, 3 - collector, for reaction products, 4 - ion collector, 5 - detector, 6 - proportional counter, 7 - surface barrier detector, 8 - moving frame

Card 4/5

ENCLOSURE: 02

ACCESSION NR: AP4043611




Block diagram of electronic apparatus
1 - gates, 2 - blocking circuits 3 - pulse analyzer 4 - high frequency block, 5 - high frequency modulation, 6 - discriminator (differential)

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Card 2/2

89-8-10/26

AUTHOR ZENKEVICH, B.A., SUBBOTIN, V.I.

TITLE The Critical Heat Flux for Burnout in Water under Conditions of Restricted Flow (Kriticheskiye teplovyye nagruzki pri vynuzhdennom dvizhenii vody, nedogretoy do kipeniya Russian)

PERIODICAL Atomnaya Energiya, 1957, Vol 3, Nr 8, pp 149 - 152 (U.S.S.R.)

ABSTRACT For efficiency reactors it is necessary to know the critical thermal stress of tubes if in these tubes water is in motion which has not yet reached the saturation temperature within the pressure range of 140-220 ata.

An experimental apparatus is described by means of which the following experimental determinations were carried out: a) Transition of boiling accompanied by formation of bubbles to complete boiling is determined by the weight of the flowing velocity $W_g$ of the water by the temperature difference $\Delta t_H$ -, which must be bridged until complete boiling occurs, and by the pressure which is characterized by the ratio V"/V" - V'. V' and V" are the specific volumes of water and steam respectively at saturation temperature. b) For the computation of the critical thermal stress $q_{Kr}$ within the pressure range of 140 - 210 ata, of the weight velocity of water of $3.10^{o}$ - $18.10^{o}$ kg/M²h, and a temperature difference

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89-8-10/26

The Critical Heat Flux for Burnout in Water under Conditions of Restricted Flow

of 10 - 100 °C the following empirically found formula can be used:

$$q_{Kr} = 590\, W_g^{0,5}\, \Delta t_H^{0,33} \left(\frac{V''}{V'' - V'}\right)^{-1,8} \text{kcal/M}^2\text{h}$$

ASSOCIATION
PRESENTED BY Not given
SUBMITTED 22.2.1957
AVAILABLE Library of Congress

Card 2/2

89-4-4-9/28

AUTHORS: Zenkevich, B.A., Subbotin, V.I., Troyanov, M.F.

TITLE: The Critical Thermal Load in the Flow of Water Over a Tube in the Longitudinal Direction, Which has not yet Attained Saturation Temperature (Kriticheskiye teplovyye nagruzki pri prodol'nom omyvanii puchka trubok vodoy, nedogretoy do temperatury nasyshcheniya)

PERIODICAL: Atomnaya Energiya, 1958, Vol. 4, Nr 4, pp. 370-372 (USSR)

ABSTRACT: Experimental determination of thermal load was carried out by means of a special apparatus, a sectional view of which is given. The tubular fuel elements (two different variants) were put together in groups of 7 or 19 each in a working channel. (Lattice spacing: equilateral triangle with a = 6 mm). For the determination of the critical point of the regime thermocouples, which were fitted in the channel, were used. The critical thermal flux ($q_{cr}$) was determined from the electric power developed and was checked by the thermal balance of the water.
If the $q_{cr}$-values in dependence on $\psi$ ($K_2$) are drawn both for the

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The Critical Thermal Load in the Flow of Water Over a Tube in the Longitudinal Direction, Which has not yet Attained Saturation Temperature

89-4-4-9/23

group of seven as well as for that of nineteen tubes, it will be found that there is good agreement between the values and the theoretically derived relation. There is, however, a deviation between the values for 7 and for 19 tubes, which is probably due to the experimental conditions. There are 3 figures, and 2 Soviet references.

SUBMITTED: November 25, 1957

1. Water--Thermodynamic properties 2. Water--Testing equipment

Card 2/2

21(4) PHASE I BOOK EXPLOITATION SOV/2583

International Conference on the Peaceful Uses of Atomic Engergy. 2nd, Geneva, 1958.

Doklady sovetskikh uchenykh; yadernyye reaktory i yadernaya energetika. (Reports of Soviet Scientists; Nuclear Reactors and Nuclear Power) Moscow, Atomizdat, 1959. 707 p. (Series: Its: Trudy, vol. 2) Errata slip inserted. 8,000 copies printed.

General Eds.: N.A. Dollezhal, Corresponding Member, USSR Academy of Sciences, A.K. Krasin, Doctor of Physical and Mathematical Sciences, A.I. Leypunskiy, Member, Ukrainian SSR Academy of Sciences, I.I. Novikov, Corresponding Member, USSR Academy of Sciences, and V.S. Fursov, Doctor of Physical and Mathematical Sciences; Ed.: A.P. Alyab'yev; Tech. Ed.: Ye. I. Mazel'.

PURPOSE: This book is intended for scientists and engineers engaged in reactor designing, as well as for professors and students of higher technical schools where reactor design is taught.

COVERAGE: This is the second volume of a six-volume collection on the peaceful use of atomic energy. The six volumes contain the reports presented by Soviet scientists at the Second International Conference on Peaceful Uses of Atomic Energy, held from September 1 to 13, 1958 in Geneva. Volume 2 consists of three parts. The first is devoted to atomic power plants under construction in the Soviet Union; the second to experimental and research reactors, the experiments carried out on them, and the work to improve them; and the third, which is predominantly theoretical, to problems of nuclear reactor physics and construction engineering. Yu. I. Moryakin is the science editor of this volume. See SOV/2081 for titles of all volumes of the set. References appear at the end of the articles.


Dollezhal', N. A., A.K. Krasin, N.A. Nikolayev, A.N. Grigor'yants, and G.N. Ushakov. Experience of Operating the First Atomic Power Plant in the USSR and the Plant's Work Under Boiling Conditions (Report No. 2183) 15

Dollezhal', N.A., A. K. Krasin, P.I. Aleshchenkov, A.N. Grigor'yants, I.V. Florinskiy, M.Ye. Minashin, I.Ya. Yemel'yanov, N.M. Mirushev, V.N. Smirnov, Yu. I. Mityayev, and A.N. Golanin. A Graphite-uranium Reactor With High Pressure Steam Superheat (Report No. 2139) 36

Aleksandrov, A.P., I.I. Afrikantov, A.I. Brandaus, A.I. Brandaus, G.A. Gladkov, B.Ya. Gnesin, V.I. Neganov, and N.S. Khlopkin. The Atomic Icebreaker "Lenin" (Report No. 2140) 60

Sirintsev, Yu. V. and B.G. Pologikh. Radiation Safety System of the Atomic Icebreaker (Report No. 2518) 87

Skvortsov, S.A. Water-water Power Reactors (VVER) in the USSR (Report No. 2184) 105

Ambartsumyan, R.S., A.M. Glukhov, V.V. Goncharov, A.I. Kovalev, and S.A. Skvortsov. Heat-producing Elements for Water-water Reactors of Atomic Power Plants (Report No. 2196) 119

Kruzhilin, G.N. and V.I. Subbotin. Cooling Water-water Reactors (Report No. 2144) 134

Yermakov, V.S. and I.V. Ivanov. A Study of Unsteady Heat Transfer in Heat-producing Elements of Nuclear Reactors (Report No. 2470) 153

Ivanovskiy, M.N., V.I. Subbotin, and P.A. Ushakov. High-speed Method of Measuring the Heat Transfer Coefficient in the Pipe (Report No. 2475) 166

Kutateladze, S.S., V.I. Subbotin, V.M. Borishanskiy, and P. L. Kirillov. Heat Exchange During the Flow of Liquid Metal in the Pipes (Report No. 2210) 176

Kazachkovskiy, O.D. Economics of Nuclear Fuel in Fast Power Reactors (Report No. 2028) 188

Belkin, V.S., P.A. Krupchitskiy, Yu.S. Sidorov, and O.V. Shvedov. Thermal Neutron Density Distribution Along the Radius of Assemblies of Rod-shaped Heat Producing Elements (Report No. 2034) 199


SUBBOTIN, V.I.

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A006/A001

Translation from: Referativnyy zhurnal, Metallurgiya, 1960, No. 10, p. 5, # 22408

AUTHORS: Kirillov, P.L., Subbotin, V.I., Suvorov, M.Ya., Troyanov, M.F.

TITLE: Investigation of Heat Transfer in a Tube to a Sodium-Potassium Alloy

PERIODICAL: V sb.: Vopr. teploobmena, Moscow, AN SSSR, 1959, pp. 80 - 95

TEXT: The authors studied heat transfer in a round Cu-tube to an eutectic 22% Na-78% K alloy. It was established that the value of the coefficient of heat transfer from the wall to the liquid metal increased with time and attained a stable value within about 800 hours of operation; this value is in a satisfactory agreement with the Martinella - Lyon (Martinella-Layon) theoretical formula $Nu = 7 + 0.0025\ Pe^{0.8}$.

A.N.

Translator's note: This is the full translation of the original Russian abstract.

Card 1/1

21(9), 24(8)

SOV/89-6-4-2/27

AUTHORS: Kirillov, P. L., Subbotin, V. I., Suvorov, M. Ya., Troyanov, M. F.

TITLE: Heat Transfer in a Tube to a Sodium-Potassium Alloy and to Mercury (Teplootdacha v trube k splavu natriya s kaliyem i k rtuti)

PERIODICAL: Atomnaya energiya, 1959, Vol 6, Nr 4, pp 382-390 (USSR)

ABSTRACT: Into a circular tube system made from (1Kh18N9T) steel a liquid Na-K-mixture and/or liquid mercury is pumped by means of electromagnetic pumps through a measuring tube (made of brass or nickel, diameter 22-40 mm, wall thickness 4-7 mm, total length 2200 mm, length of heated part of the tube ~1100 mm), and the heat transfer is measured. For this purpose a mobile special thermocouple (a sectional drawing of which is given) is constructed. Further thermocouples of various composition are fitted to the walls of the actual range of measurement. The fact that the thermocouples are composed of different materials and are checked by means of a blank test to a certain extent warrants reproducibility of the measuring results. Moreover, devices for measuring the quantity of heat are connected within the measuring circuit for purposes of

Card 1/3

control. Search thermocouple may be let into the Na-K and Hg current respectively. For the purpose of measuring the electromotive force generated by the thermocouples the potentiometer PPTN-1 is used in conjunction with a mirror galvanometer M-21/4. The NaK circulates through filters and cooling trap, so that the oxygen content in the Na-K-circulation may be reduced down to 0.003 % by weight. On the basis of the experimental data the following conclusions may be drawn: 1) The heat transfer coefficients for Na-K were determined twice, viz.: a) from the wall temperatures of the measuring tube, and b) from the temperature distribution of the flowing Na-K. From both measurements it may be concluded that a contact resistivity to heat exists, which varies with time. The amount of the thermal contact resistivity depends on the oxygen content of the Na-K alloy. It is graphically represented as a function of time (Fig 5). 2) Measurement of the heat transfer coefficients of nickel (measuring tube material) on mercury shows that no thermal contact resistivity exists. Thus, the material of the contact surface influences heat transfer. 3) By using the mobile thermocouple it was possible to find out that the results are not falsified by

Heat Transfer in a Tube to a Sodium-Potassium Alloy and to Mercury SOV/89-6-4-2/27

boundary effects and that the length of the heat stabilization for the hydraulically stabilized current is 10 l/d (l/d - the specific length of the heated part of the measured distance). 4) For the case mentioned under 2), the data obtained agree well with the data obtained from references 4 and 5. The heat transfer coefficient may be represented by the equation $Nu = 7 + 0.025\,(\varepsilon\,Pe)^{0.8}$, where $\varepsilon \simeq 1$. There are 9 figures, 1 table, and 10 references, 6 of which are Soviet.

SUBMITTED: June 25, 1958

Card 3/3

Subbotin, V.I.

PHASE I BOOK EXPLOITATION SOV/4396

Akademiya nauk SSSR. Energeticheskiy institut

Konvektivnyy i luchistyy teploobmen (Convection and Radiation Heat Exchange) Moscow, Izd-vo AN SSSR, 1960. 254 p. Errata slip inserted. 3,200 copies printed.

Ed.: M.A. Mikheyev, Academician; Ed. of Publishing House: G.B. Gorshkov; Tech. Ed.: V.V. Brusgul'.

PURPOSE: The book is intended for scientists and engineers working in various branches of science and industry concerned with thermodynamics and heat transfer problems.

COVERAGE: The book consists of 19 original articles on various problems in thermodynamics. The following subjects are discussed: mechanism of heat transfer processes, intensification of heat exchange, determination of thermophysical properties of operating media, heat transfer in supersonic flow of gas, and combustion chambers and nuclear reactors. Theory and experimental techniques are described. Each article describes the conditions of the experiment and tables of the experimental data obtained are given. The data may be used for calculations of heat transfer and heat exchangers, always taking account of


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77210
SOV/89-8-1-4/29

21.1320

AUTHORS: Kirillov, P. L., Kozlov, F. A., Subbotin, V. I., Turchin, N. M.

TITLE: Purification of Sodium From Oxides and Methods of Control of Oxide Content

PERIODICAL: Atomnaya energiya, 1960, Vol 8, Nr 1, pp 30-36 (USSR)

ABSTRACT: Oxides in sodium used in liquid heat exchangers in reactors produce corrosion and tend to produce deposits in cooler parts of the contours which can cause clogging. The authors investigated, therefore, cold traps for oxides and a plug indicator for oxides. They wanted to avoid chemical methods which, besides being complicated and time-consuming, become extremely complex in the case of radioactive sodium. The setup on Fig. 2 utilizes the well-known relation between the solubility of oxygen in sodium and its temperature:

$$W = 2,7 \cdot 10^{-4} \left( \frac{t}{100} \right)^{3,6} \qquad (1)$$

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

where W is solubility of oxygen ( % weight); t is temperature (° C). It makes possible determination of oxide content. As soon as the temperature drops below the temperature of saturation for oxides in sodium, precipitation takes place, clogging the slots on the main valve, and the flow of sodium decreases as shown in Fig. 3. The authors varied oxygen concentration from 0.002 to 0.1% weight, the temperature from 110 to 550° C, and the size of slots from 0.5 x 0.5 mm to 1 x 1 mm. The number of slots should be 10 to 15 to reduce effects of accidental clogging. The readings were independent of the cooling rate of sodium while the oxygen concentration varied between 0.008 and 0.02% weight, the metal velocity between 2.5 and 13 m/sec, and the rate of decrease of the valve temperature between 0.3 and 37° C/min. Table 3 shows comparative data from the method described here and the chemical analysis. The authors investigated the cold trap shown in Fig. 5. On this figure, 1

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

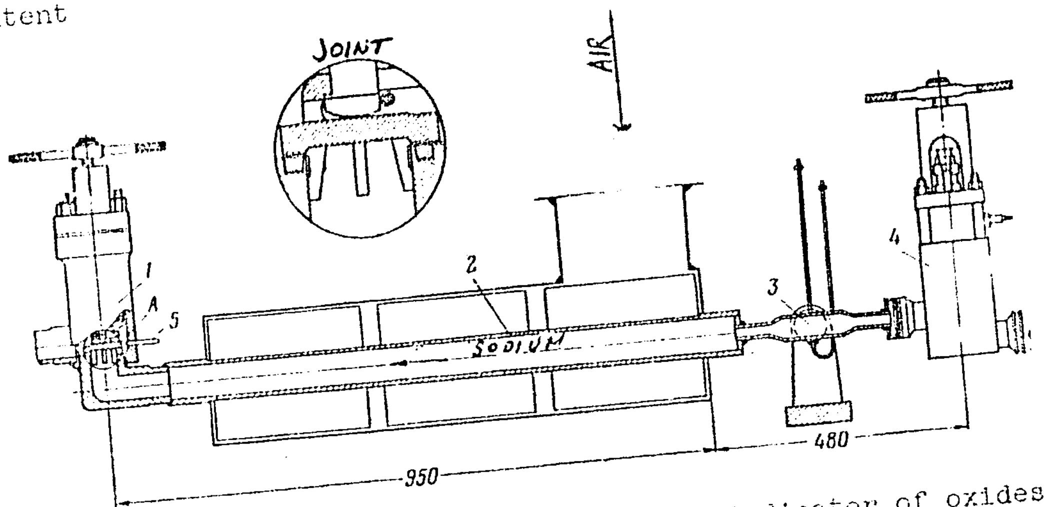


Fig. 2. Construction of plug indicator of oxides: (1) basic valve with radial slots in the disk stopping the oxide; (2) sodium-air heat exchange; (3) flow meter; (4) throttle valve; (5) thermocouple for temperature measurements at the clogging spot.

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

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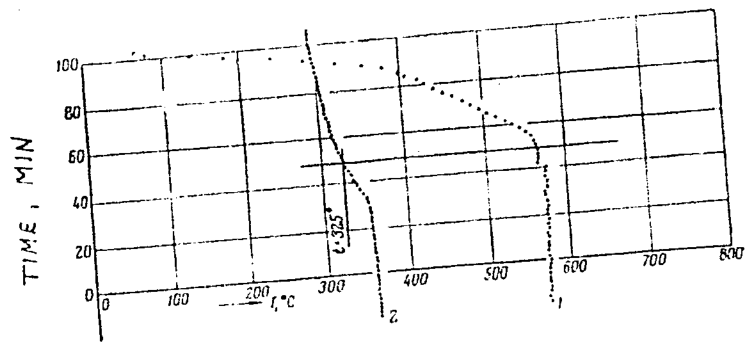


Fig. 3. Examples of registered curves of flow and temperature of sodium on the iterative (secondary) oxide indicator. (1) Emf of magnetic flow meter; (2) temperature of the flap of the basic valve.

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

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Table 3. Oxide content in the trap determined by the two methods, in g.

| Number of the trap | Data from the indicator of oxides | Data from the gas analysis |
|---|---|---|
| 1 | 890+100 | 1,000+500 |
| 10 | 4,750±700 | 6,200±900 |

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

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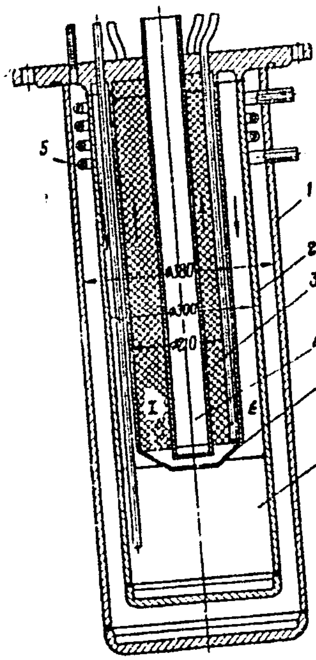


Fig. 5. Construction of cold trap. Capacity, 32 l of sodium.

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

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% weight ($t'$ is lowest temperature of the metal in the trap); $Q$ flow of metal through the trap in $m^3/h$; $\gamma$, specific gravity of the metal at the temperature of the contour, in $kg/m^3$; $\tau$, operating time of the trap in hours. After discussing the conditions of validity of Eq. (2), the authors perform the integration and obtained:

$$c = c' + (c_0 - c')\, e^{-n} \qquad (3)$$

where $c_o$ is original concentration of oxygen in sodium; $n$ is number of times the whole amount of sodium passed through the trap during time $\tau$; $n = \frac{Q\tau}{V}$. This equation was used as a check on experimental results since a removal of oxides from the trap raised the experimental points above the calculated ones. The authors give detailed data about experimental results

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SOV/89-8-1-4/29

Purification of Sodium From Oxides and Methods of Control of Oxide Content

with two traps of different sizes. They concluded that the cold trap can reduce the content of oxygen in sodium down to 0.002% weight, that any required reduction is possible by proper adjustment of operating conditions, that the efficiency of the trap increases after some oxides are already deposited; that chips in the trap work better than wire of 0.5 mm diameter, and that the capacity of the trap increases with the flow velocity. The authors measured also the variation of the concentration of oxygen as a function of n (the experimental points follow quite well the theoretical curve from Eq. (3)) and the longitudinal temperature distribution inside the trap. There are 4 tables; 7 figures; and 15 references, 8 Soviet, 2 U.K., 5 U.S. The 5 most recent U.K. and U.S. references are: A. McIntosh, K. Bagley, J. Brit. Nucl. Energy Conference, 3, Nr 1, 15 (1958); J. White, Nucl. Sci. Abstrs., 15, 8290 (1957); O. Salmon, T. Cashman, J. Inst. Metals,

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Purification of Sodium From Oxides and Methods of Control of Oxide Content

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SOV/89-8-1-4/29

84, 7 (1956); J. Grey, R. Neal, B. Voorhess, Nucleonics, 14, Nr 10, 34 (1956); W. Bruggemann, J. Amer. Inst. Chem. Engr, 2, 153 (1956).

SUBMITTED: April 20, 1959

Card 10/10

21.1200,24.5200

77218
SOV/89-8-1-12/29

AUTHORS: Ibragimov, M. Kh., Subbotin, V. I., Ushakov, P. A.

TITLE: Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

PERIODICAL: Atomnaya energiya, 1960, Vol 8, Nr 1, pp 54-56 (USSR)

ABSTRACT: Two setups were used, one for mercury and the other for lead and an eutectic alloy of lead and bismuth (43.5% Pl + 56.5% Bi). Experiments with mercury. The 99.9% pure mercury R-3 was sent through a suede filter. It circulated in the apparatus through a countercurrent heat exchanger of 17 x 12.5 mm tube diameter made of stainless steel 1KH18N9T. Water circulated in the annular space 4.5 mm wide, and the useful heat-exchange region was 760 mm long. A region of hydrodynamic stabilization equal to 40 diameters was provided at the entrance to the heat exchanger. Auxiliary heaters on both ends prevented escape of heat along the tube, and the temperature at both ends was measured by thermocouples. The

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Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

77218
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heat transfer was then determined in the usual way. The arithmetic average of the thermocouple temperature was used as the average mercury temperature while the average temperature on the heat-exchange surface was obtained after planimeter measurements of the temperature profile along the exchanger. Correction was made for the depth of the build-in of the thermocouples. Lead and lead-bismuth alloy experiments. Argon was used to prevent oxidation of the liquid metal, previously purified from oxides by hydrogen reduction. Chemical analysis showed that during the experiment the oxygen content was practically constant at $1 \cdot 10^{-3}$ % weight. The tube was of 12 x 9 mm diameter of stainless steel 1KH18N9T, with a brouched inner surface. Temperature was measured using a resistance thermometer of platinum wire 0.07 mm in diameter, 1800 mm long and taped every 118 mm. The thermometer was 33 diameters away from the origin of the heating region. Liquid metal temperature at the entrance was also measured

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Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

with a resistance thermometer while the heat carrier temperature was determined using a chromel-alumel thermocouple. The discharge of the liquid metal was determined using a previously calibrated magnetic flowmeter. The heat flow was produced by electric heating. The length of the heat-exchange region was 520 mm. Experimental results. The average heat exchange coefficient of mercury was determined in a region of the heat exchanger equal to 60 diameters. The section of preliminary hydrodynamic stabilization was equal to 40 diameters, while the lead and lead-bismuth alloy measurements refer to a region 33 diameters from the origin of the heated region and 41 diameters from the entrance into the tube. The results are, therefore, in the stable region. The limits of variation for some of the pertinent quantities are given in the table.

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Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

Variation of quantities during experiments.

| Parameters | Mercury | Lead | Eutectic alloy lead-bismuth |
|---|---|---|---|
| Temperature, °C | 24—48 | 400—420 | 250—340 |
| Preheating, °C | 1—13 | 1,5—3 | 1—22 |
| Temperature head, °C | 3—14 | 2—3,2 | 1,4—5,3 |
| Velocity of liquid metal, m/sec | 0,4—4 | 1,5—3,5 | 0,2—5,6 |
| Heat load, Kcal/m²·hour | (20—100)·10³ | 42·10³ | (11—52)·10³ |
| Coefficient of heat transfer, Kcal/m²·hour | (4—15)·10³ | (13—23)·10³ | (6,6—24)·10³ |
| Prandtl number, Pr·10³ | 22—27 | 20 | 20—27 |
| Reynolds number, Re·10⁻³ | 40—400 | 65—160 | 8—290 |
| Peclet number, Pe·10⁻³ | 1—10 | 1,3—3,2 | 0,2—5,8 |
| Nusselt number, Nu | 7—27 | 8,6—15 | 6—19 |

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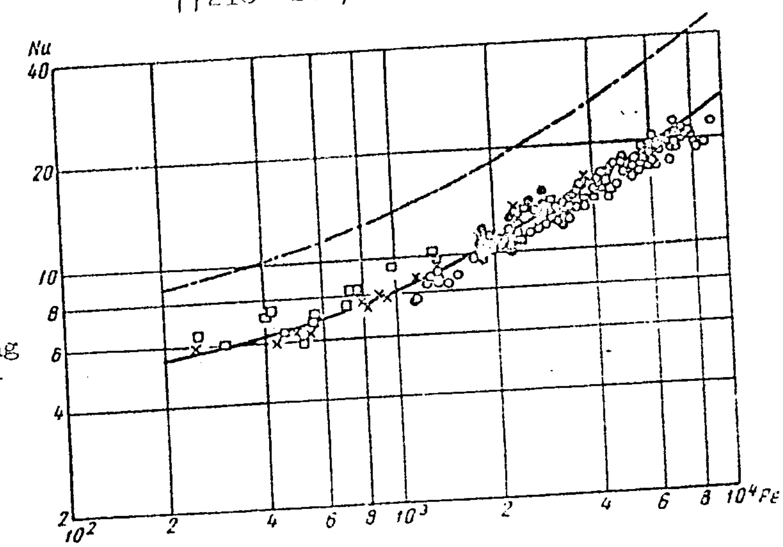


Experimental results processed utilizing similarity criteria:

o - mercury; • - lead; □ - eutectic alloy lead-bismuth; x - eutectic alloy lead-bismuth with the addition of 0.1% magnesium; —— - according to the equation in reference /1/ (above $Nu = 4.5 + 0.014\ Pe^{0.8}$; — · — · — · — according to the equation by Lyon, $Nu = 7 + 0.025\ Pe^{0.8}$.

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Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

The results agree with the Eq. (1) probably because the liquid metals were not purified during the experiment, and the heat-exchanging surface was not subjected to moistening. One can then assume that under such conditions there existed a thermal resistance which led to disagreement with the curve obtained by using Eq. (2). In later experiments the authors determined the temperature field inside the flow of liquid metal. Computing the coefficients of heat irradiation by extrapolating the temperature profile all the way to the walls, they obtained results in agreement with Eq. (2). Kh. A. Khachaturov, A. A. Sholokhov, V. I. Petrovichev, Ye. V. Nomofilov, and O. V. Remizov took part in building equipment and collecting experimental data. There is 1 figure; and 8 references, 5 Soviet, 1 U.K., 2 U.S. The U.K. and U.S. references are: H. Brown, B. Amstead, B. Short, Trans. ASME, 79, 279 (1957); R. Lyon, Chem. Engng. Progr., 47, 25 (1951); S. Isakoff, T. Drew, General Discussion on Heat Transfer,

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77218
SOV/89-8-1-12/29

Investigation of Heat Irradiation During Turbulent Flow of Heavy Metals Through Pipes. Letter to the Editor

London Conference, 1951, p 405.

SUBMITTED: January 6, 1959

Card 8/8

24.5200

78328
SOV/89-8-3-13/32

AUTHORS: Subbotin, V. I., Ibragimov, M. Kh., Ivanovskiy, M. N.

TITLE: Turbulent Temperature Pulsations in a Flow of Liquid. Letter to the Editor

PERIODICAL: Atomnaya energiya, 1960, Vol 8, Nr 3, pp 254-257 (USSR)

ABSTRACT: Pulsations of velocity of a turbulent flow of liquid cause turbulent temperature pulsations during heat exchange. The authors investigated the effect using movable thermocouples of low heat capacity. One type consisted of an open junction 0.2 mm in diam and the other of a junction inside a thin-walled container 0.5 or 0.8 mm in diam. One construction is described in detail by Kirrillov and others (Atomnaya energiya, 6, Nr 4, 382 (1959)). The heat flow was produced by means of electrical heating elements. The thermocouple data were registered by means of fast automatic potentiometers EPP-09 Class 0.5, covering the whole scale, 0 to 0.5 mv, in 1 sec. Results are shown on Fig. 1 and 2.

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Turbulent Temperature Pulsations in a Flow of Liquid. Letter to the Editor

78328
SOV/89-8-3-13/32

Typical liquid metal time curve of pulsation is shown in Fig. 3. Similar results were obtained in water. The authors found that the amplitude and frequency of temperature pulsation depend on the size of the heat flow, the physical properties, the type of flow of the liquid, and on the dimensionless distance from the wall. Temperature pulsations inside the wall were damped as one leaves the heat exchange region. It was established that pulsations persist some 2-5 sec after the end of heating and then start slowly to dampen out. The reverse happens after switching the heat on. The pulsations accompany the existence of a temperature gradient in the liquid. Various methods of pumping had no influence on the pulsations. Likewise, the frequency of the heater current and 3% fluctuations of the heating power did not produce any change in the pulsation pattern. The authors took care to eliminate all possible causes of mechanical vibrations, and they are sure that the measured temperature oscillations are due to the turbulent pulsations of the temperature

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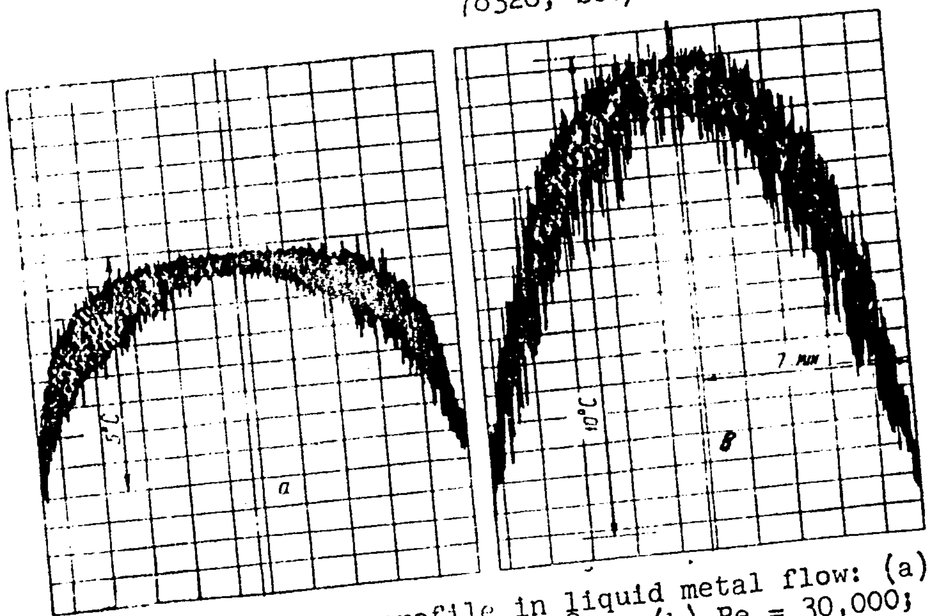


Fig. 1. Temperature profile in liquid metal flow: (a) Re = 230,000; q = 50,000 kcal/m$^2$·h; (b) Re = 30,000; q = 20,000 kcal/m$^2$·h.

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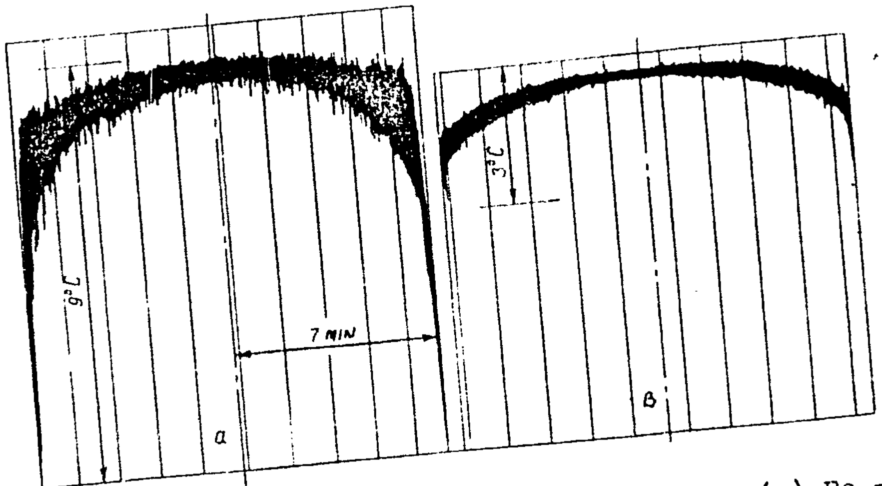


Fig. 2. Temperature profile in water flow: (a) Re = 8,900; q = 30,000 kcal/$m^2$·h; (b) Re = 35,000; q = 50,000 kcal/$m^2$·h.

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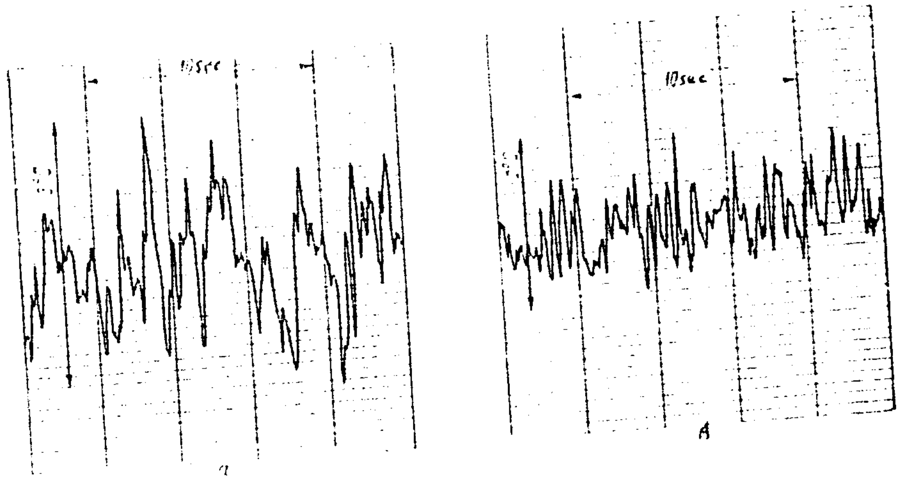


Fig. 3. Time curve of temperature pulsation of a flow of liquid metal in region of maximum amplitudes: (a) Re = = 30,000; q = 20,000 kcal/m$^2$·h; (b) Re = 230,000; q = 50,000 kcal/m$^2$·h.

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in the flow. The amplitude variations with radius observed on Figs. 1 and 2 agree with the hypothesis that the magnitude of turbulent temperature pulsation is proportional to the mixing path length 1 and the temperature gradient, except that the pulsations differ from zero even in the center of the tube and on its walls. Thermocouples used were able to react to frequencies up to 100 cycles/sec without amplitude distortion. The registering device could follow up to 20 c/sec. The frequencies registered in these tests obviously did not represent the whole spectrum of temperature pulsations, and the authors plan to continue investigations using still more perfected instruments with small thermal inertia. Ye. V. Nomofilov, M. N. Arnol'dov, and Yu. N. Pokrovskiy helped build the experimental apparatus and took part in measurements. A. I. Leypunskiy and A. P. Aleksandrov gave advice and showed interest in the work. There are 4 figures; and 2 Soviet references.

SUBMITTED: October 12, 1959

SUBBOTIN, V.I.; USHAKOV, P.A.; GABRIANOVICH, B.N.

Hydraulic resistance to the flow of a liquid about a bundle of rods.
Atom.energ. 9 no.4:308-310 O '60. (MIRA 13:9)
(Hydraulics)

84231

Investigation of Heat Exchange in a Turbulent Flow of Mercury in an Annular Gap

S/089/60/009/004/011/020
B006/B070

experimental dimensions (1,000 mm, gap width 1 mm) was somewhat lower. The experiments showed first that the flextures of the inner tube ($d_2/d_1 = 1.05$) had a significant effect on the temperature field. This shows that in designing heat exchangers the effect of channel deformations may not be neglected. The most important results were obtained for the second experimental dimensions for which channel deformations could be practically excluded. Fig. 1 shows the temperature distribution along the gap for $q = 50 \cdot 10^3$ kcal/m$^2$.hour; Fig. 2 shows a comparison between the experimental results and calculations according to semi-empirical formulas; Fig. 3 gives a comparison of the experimental results by the present authors with the experimental results of other authors. The experimental results are summarized as follows: 1) For two-sided heating of a gap with $d_2/d_1 \leq 1.09$ and for equality of the heat flows from both heat-emitting surfaces to the mercury, the heat transfer is about double as much as for a one-sided heating (Fig. 2). Therefore, the use of the hydraulic diameter $d_h$ as a characteristic dimension does not automatically take into account the specialities of heat transfer to liquid metals for a

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SUBBOTIN, V.I., USHAKOV, P.A.; GABRIANOVICH, B.N.; ZHUKOV, A.V.

Heat exchange during the flow of mercury in a closely packed assembly of rods. Atom. energ. 9 no.6:461-469 D '60. (MIRA 13:12)
(Mercury) (Heat—Transmission)

SUBBOTIN, V.I., ZENKEVICH, B. A., and REMIZOV, O. V.,

"On the Effect of a Duct Geometry on Critical Heat Loads at the Forced Motion of Water."

Report submitted for the Conference on Heat and Mass Transfer, Minsk, BSSR, June 1961.

SUBBOTIN, V.I.; IBRAGIMOV, M.Kh.; IVANOVSKIY, M.N.; ARNOL'DOV, M.N.; NOMOFILOV, Ye.V.; ATENKOV, S., tekhn. red.

[Heat transfer and turbulent heat transport in a flow of luquid metals; Conference on Heat and Mass Transfer, Minsk, January 23-27, 1961] Teplootdacha i turbulentnyi perenos tepla v potoke zhidkikh metallov; soveshchanie po teplo-i massoobmenu, g. Minsk, 23-27 ianvaria 1961 g. Minsk, 1961. 18 p. (MIRA 15:2)
(Heat—Transmission) (Liquid metals)

29918
S/594/61/000/000/006/011
D234/D303

26.5000 (1498)

AUTHORS: Subbotin, V.I., Ibragimov, M.Kh. and Nomofilov, Ye.V. (Moscow)

TITLE: Measuring turbulent pulsations of temperature in a stream of liquid

SOURCE: Soveshchaniye po teplo- i massoobmenu. Minsk, 1961. Tezisy dokladov i soobshcheniy (Dopolneniye), 38-39

TEXT: Turbulent pulsations of temperature in the flow of liquid metal and water in a pipe were measured. The amplitude of temperature pulsations obey Gauss Law of Normal Distribution. A variation of the amplitude of the pulsations with the radius was detected which, in the range of maximum amplitudes, agrees with the hypothesis that the magnitude of the pulsations is proportional to the length of the path of mixing and to the gradient of the averaged temperature field. At all points of the turbulent stream the intensity of the pulsation decreases with the increase of the num-

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S/594/61/000/000/006/011
D234/D303

Measuring turbulent pulsations...

ber Re. Mean frequency of the pulsations varies little with the cross section of the stream. Temperature pulsations were found in the layer at the wall of the pipe and in the wall. It is shown that the thickness of the layer at the wall varies continually in an accidental manner, but the layer does not disappear completely. If there is stationary cooling the process of heat transfer through the layer at the wall and the surface of heat exchange is quasi-stationary. Increase of mean frequency of the pulsations in the wall and in the stream was found from zero values (Re < 2000) to approximately 1 cycle (for Re $\simeq$ 2300) which indicates that a turbulent regime of flow appears. [Abstracter's note: Essentially a complete translation]

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29919
S/594/61/000/000/008/011
D234/D303

26.5000 (a lso 1498)

AUTHORS: Subbotin, V.I., Ibragimov, M.Kh., Ivanovskiy, M.N., Arnol'dov, M.N. and Nomofilov, Ye.V. (Moscow)

TITLE: Heat loss and turbulent heat transfer in streams of liquid metals

SOURCE: Soveshchaniye po teplo- i massoobmenu. Minsk, 1961. Tezisy dokladov i soobshcheniy (Dopolneniye), 39-41

TEXT: Coefficients of heat loss and turbulent heat transfer were determined on the basis of measuring temperature fields in streams of various alkaline and heavy liquid metals. The liquid metals investigated have a sufficiently wide range of measurement [Abstracter's note: "izmereniye" - probably a misprint of "izmeneniye" - change, variation] of the criterium Pr = 0.005 ÷ 0.05. Several experiments with measurement of temperature fields were made on water. Turbulent pulsations of temperatures in the stream were found, whose magnitude was up to ± 20% of the value of tempera-

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S/594/61/000/000/008/011
D234/D303

Heat loss and turbulent heat...

values of the number Pe. Data processing on temperature fields obtained showed that the above ratio varies with the radius of the pipe and depends on the criterium Re. The coefficient of turbulent heat transfer was determined from

$$\varepsilon_a = \frac{q/q_w}{\frac{\partial t}{\partial \xi}} \frac{r_0 q_w}{c_p \gamma} - a \qquad (2)$$

The ratio of local heat flow and the flow at the wall was found from a relation obtained from the heat balance of an elementary volume of the liquid. In several experiments the coefficient of heat loss was determined by the same methods, in which the thermal contact resistance on the surface of heat exchange was taken into account. The experiments allowed the authors to make a sufficiently clear distinction between two processes which determine the heat transfer to liquid metals. The first process, connected with molecular and turbulent heat transfer, can be described by semi-empirical theories of heat exchange. Such heat transfer is described in

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S/594/61/000/000/008/011
D234/D303

Heat loss and turbulent heat...

the first approximation by the Martinelli-Lyon theory. The second process, caused by thermal contact resistance on the surface of heat exchange, defies theoretical estimation at present. [Abstracter's note: Complete translation]

Card 4/4

23556

S/096/61/000/007/004/006
E194/E155

21.4240

AUTHORS: Ibragimov, M.Kh., Candidate of Technical Sciences, Nomofilov, Ye.V., Engineer, and Subbotin, V.I., Doctor of Technical Sciences.

TITLE: Heat transfer and hydraulic resistance during helical motion of a fluid in a tube

PERIODICAL: Teploenergetika, 1961, No. 7, pp. 57-60

TEXT: This article describes the influence of the additional turbulence caused by helical motion of fluid in a tube. The tests were carried out with water (Pr > 1) and liquid metal (Pr ≪ 1) which were of different thermal conductivity. Measurements were made both of heat transfer and hydraulic resistance. The resistance tests were made in a tube of steel 1Х18Н9Т (1Kh18N9T) of 12 mm internal diameter, 1020 mm long, with an internal finish of class 5. Into this were inserted twisted strips of metal to cause the helical flow. Tests were made with helix pitches of 50.5, 109.5 and 238 mm and with a flat central strip. Resistance-test results are plotted in Fig.1, in which the black points (1) correspond to a pitch of 50.5 mm and the circles (2) to the other

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S/096/61/000/007/004/006



two pitches and the straight strip. It will be seen that the resistance rose sharply as the helix pitch dropped below 109.5 mm. The heat-transfer tests were made in a tube of steel 1Kh18N9T with an internal diameter of 12 mm and a test portion 680 mm long. The latter was enclosed in a ceramic tube wound with an electric strip heater. The internal twisted strips tested had pitches of 50.5 and 109.5 mm, and a flat strip was also used. Heat-transfer test results with water are plotted in Fig.4, where the experimental points (1) correspond to a pitch of 50.5 mm, points (2) to 109.5 mm, points (3) to a flat strip and points (4) to the tube without any strip. The influence of the twisted spiral on heat transfer with water may be allowed for by introducing a correction factor $K_T$ into Mikheyev's formula

$$Nu = 0.021\ Re^{0.8}\ Pr^{0.43} \left(\frac{Pr_{ct}}{Pr_{ж}}\right)^{0.25} K_T \qquad (4)$$

The correction factor $K_T$ is given by the following expression:

$$K_T = 1 + A \left(\frac{d_{BH}}{s}\right)^n \frac{1}{Re^m} \qquad (5)$$

23556

S/096/61/000/007/004/006

Heat transfer and hydraulic resistance...E194/E155

where: $d_{BH}$ is the internal diameter; s is the pitch; and for values

$$0 \leq \frac{d_{BH}}{s} \leq 0.25 \quad \text{and} \quad 10^4 \leq Re \leq 4 \times 10^4,$$

$$A = 1.13 \times 10^5; \quad n = 1\varphi \quad m = 1.2$$

For tubes alone and with untwisted strips, $K_T = 1$. Formula (4) gives satisfactory representation of the experimental results for water. The results for liquid metal worked out in terms of the Nu and Pe criteria are plotted in Fig.6. The two curves correspond to the upper and lower ranges of heat-transfer coefficients published for liquid metals. In Fig.6, points (1) correspond to a pitch of 50.5 mm, points (2) to a pitch of 109.5 mm, points (3) to a straight strip, and points (4) to a tube without strip. It will be seen that in the case of liquid metal which is a good conductor of heat the increased turbulence due to helical flow has no appreciable influence on the heat transfer.
There are 6 figures, 1 table and 4 references: 3 Soviet and 1 English. The English language reference reads as follows:
Ref.3: R.N. Lyon. Chem. Eng. Progr. Vol.47, No.2, 1951.

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25669
S/096/61/000/009/006/008
E194/E155

An investigation of heat uptake by ...

that the oxides in suspension accumulate preferentially in the layer near the wall. It is also possible for the oxides to accumulate in the corners of the duct. An approximate analysis of heat transfer in a rectangular duct gives the following expression for the temperature distribution on the internal surfaces of the walls:

$$\frac{t_w - t_0}{qd_э} \lambda_1 = f\left(Pe, \frac{x}{d_э}, \frac{y}{d_э}, \frac{\delta_1}{d_э}, \frac{\delta_2}{d_э}, \frac{z_0}{d_э}, \frac{\lambda_2}{\lambda_1}\right) \quad (5)$$

where: $t_w(x, y)$ is the temperature of the heat-transmitting wall of the duct; $t_0$ is the temperature of the heat transfer medium at inlet to the duct; $q$ is the specific thermal flux through the wall averaged over the surface; $d_э$ is the equivalent diameter; $\lambda_1$, $\lambda_2$ are coefficients of thermal conductivity of the liquid and wall respectively; $x$ is the coordinate of the length of the duct; $y$ is the coordinate of the width of the duct; $z$ is the coordinate of the height of the duct; $\delta_1$ is the thickness of the heat-transmitting wall; $\delta_2$ is the thickness of the end wall; $2z_0$ is the height of the section.

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S/096/61/000/009/006/008
E194/E155

An investigation of heat uptake by ....

A great deal of experimental data and calculations would be required to determine the functional relationships. However, the authors have made a series of experiments on heat transfer in rectangular ducts and some of the results are given in this article. The heat transfer medium used was mercury of 99.9% purity, and it was filtered whilst in circulation. The experimental section was a duct of section 50 x 11.8 mm, 1000 mm long, made of steel 1Х18Н9Т (1Kh18N9T). Electric heaters were provided. Thermal losses on the experimental section were not measured or compensated but it is estimated that they were less than 1% of the applied thermal energy. In tests made with heating from two sides, the specific thermal fluxes through each of the heat-transmitting walls were the same to within 2 - 3%. The heat input was compared with the increased heat content of the mercury in the duct; the average difference was ± 2%. It was not possible to detect temperature variations over the length of the duct. Fig.3 shows experimental data on variations in the wall temperature distribution across the width of the duct with heat applied from both sides for the various values of Pekle's number indicated:

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altogether clear why in the present case the experimental data for the mean heat-transfer coefficient in a rectangular duct are in good agreement with theoretical calculations. The coincidence may apply only to this specific case. The demonstration of relatively high irregularity of temperature across the width of the heat-transmitting wall is of considerable importance in reactor design. It is necessary to make further investigations of special features of local heat transfer and hydrodynamics in rectangular ducts, so as to develop methods of calculating the temperature distribution in such cases.

There are 7 figures and 8 references: 5 Soviet and 3 English. The English language references read as follows:

Ref.1: as quoted above.
Ref.2: as quoted above.
Ref.5: B. Lubarsky, S.I. Kaufman, National Advisory Committee for Aeronautics Report 1270, 1956.

89923

S/170/61/004/003/001/013
B117/B209

Investigation of heat ...

sections on the pipe surface, twelve copper-constantan thermocouples insulated with Vinylflex were mounted. The soldered junctions of the thermoelectric cells were ~0.2 mm under the heat exchange surface. Water temperature was measured at both the outflow and inflow end of every cell. The e. m. f. of the thermocouples was measured by means of a low-resistance potentiometer of the ППТН-1 (PPTN-1)-type, with an M25/4 (M25/4) mirror galvanometer. Three series of tests were made with a pipe bundle with a central steel pipe. In the first series, the heat exchange with specific heat currents of 64 $10^3$ and 94.2 $\cdot$ $10^3$ kcal/m$^2$ $\cdot$ hr with all pipes heated was measured. The second series served the study of the effect of the jacket upon the heat exchange in the central cells, with all pipes and the jacket being heated. In the third series, the effect of the heating of all pipes upon the heat exchange with the central pipe was investigated with the central pipe only heated internally: q = 94.2 $\cdot$ $10^3$ kcal/m$^2$ $\cdot$ hr. In experiments with a copper pipe, only the central one was heated; here, the specific heat current was 64 $\cdot$ $10^3$ kcal/m$^2$ $\cdot$ hr. Comparison of the experimental data with the formula suggested by M. A. Mikheyev (Sb. "Teplootdacha i teplovoye modelirovaniye", Izd. AN SSSR, 1959) for round pipes showed

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B117/B209

Investigation of heat ...

that the experimental points exceed this function by 20 - 40%. The spread of the experimental points increased due to correction ($Pr_f/Pr_w$) which accounts for the variation of physical parameters of the liquid in the cross section of the canal. The data obtained by heating the central pipe only and by heating all pipes in the bundle were connected by a satisfactory relation. Heating of the jacket hardly changes the heat exchange in the central cells. This offers the possibility of extending the obtained results to bundles with a large number of rods. Formula (6) $Nu_f = 0.0205 Re_f^{0.84} Pr_f^{1/3}$ gives a good approximation to the experimental points. The calculated $Re_f$ and $Nu_f$ characteristic numbers differ in the range concerned by 7 % at most. The results were compared with those of other authors. The errors in measuring the heat exchange coefficient were estimated. Capacity was determined with an accuracy of ± 2%. The geometrical errors did not exceed ±1%. Temperature was measured with an accuracy of ±0.1°C. The errors due to the correction error with respect to the installed thermocouples did not exceed ±2% in measuring the temperature gradient between wall and liquid. The calculated maximum errors on measurement of the heat exchange coefficients in the investigated

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Investigation of heat ...

S/170/61/004/003/001/013
B117/B209

range of Re numbers amounted to ±(8 - 15)% for the steel pipe and to ±(7 - 11)% for the copper pipe. Mention is made of A. S. Sinel'nikov, A. P. Salikov, Ya. L. Polynovskiy, and K. I. Belyakov. There are 5 figures and 10 references: 7 Soviet-bloc.

Card 4/4

11.3950
11.9200

S/089/61/010/004/010/027
B102/B205

AUTHORS: Subbotin, V. I., Ibragimov, M. Kh., Ivanovskiy, M. N., Arnol'dov, M. N., Nomofilov, Ye. V.

TITLE: Turbulent heat transfer in a flow of liquid metals

PERIODICAL: Atomnaya energiya, v. 10, no. 4, 1961, 384-386

TEXT: The modern theory of turbulence does not permit an analytic determination of a turbulent heat transfer in a flow of liquid matter. As shown by the present study, the semi-empirical theory of heat transfer which makes use of the analogy of heat transfer and momentum transfer, makes it possible to perform such studies. This can be proved by measuring the temperature fields in liquid metals. On account of the high thermal conductivity of liquid metals, the temperature drop is not limited to a thin, laminated layer like in ordinary liquids but extends to the turbulent core. Martinelli was the first to apply the theory of hydrodynamical analogy to liquid metals, taking into account the molecular heat conductivity in the turbulent core of the flow. Calculations were based on the assumption that the ratio of the coefficients of turbulent heat transfer

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22613

and of momentum transfer ($\varepsilon_a/\varepsilon_v$) were independent of the radius and the flow velocity. Lion has derived a general equation for the heat-transfer coefficient in a tube:

$$\frac{1}{Nu}=2\int_0^1 \frac{\left[\int_0^1 \frac{u}{w}\xi d\xi\right]^2}{\left(1+\varepsilon\frac{\varepsilon_v}{\nu}Pr\right)\xi}d\xi, \qquad (1)$$

where $\xi = r/r_o$ and, using the results of Martinelli with $\varepsilon = \varepsilon_a/\varepsilon_v = 1$, he obtained $Nu = 7 + 0.025\,Pe^{0.8}$. Martinelli's and Lion's assumption that $\varepsilon = 1$ has not yet been confirmed experimentally. Voskresenskiy, Deissler, Jenkins et al. have found experimentally that $\varepsilon$ was much smaller than 1. On the basis of measurements of the temperature fields in flowing water and flowing liquid metals, the authors have made an attempt to determine the turbulent heat-transfer coefficient and $\varepsilon$ for liquid metals, and to study the effect of the thermal conductivity of the metals on these quantities. The former quantity was calculated from the equation

$$\varepsilon_a = \frac{q/q_o}{\partial t/\partial \xi}\,\frac{r_o q_o}{c_p \gamma} - a \qquad (3).$$

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B102/B205



The ratio of the local heat flow to the heat flow on the wall was found from the equation

$$q/q_0 = \frac{1}{\xi}\frac{u^*}{w}\left[(4.25 + 2.5 \ln y^+)\xi^2 - 2.5\xi - 2.5(1 - \xi^2)\ln(r_0/y)\right].$$

The temperature gradients determined by graphical methods make it possible to calculate $\varepsilon_a$ from Eq. (3). Fig. 1 shows the distribution of $\varepsilon_a$ across the tube cross section. $\varepsilon_a$ grows with increasing distance from the wall and with increasing Re number, wherefrom it follows that $\varepsilon_a \neq 0$ in the center of the tube. The curves shown in Fig. 1 hold for a heavy metal. The $\varepsilon_a(\xi)$ curves taken for alkaline metals show a similar course, but the maximum is hardly marked at high Re numbers. Fig. 2 shows the experimental curves $\varepsilon_a/\lambda = f(\xi)$ (continuous lines) as compared with those calculated according to Lion (-·-·-·) and those obtained for heavy metal (A) and alkaline metal (B) according to Voskresenskiy (-----). A comparison between measured and theoretically determined temperature fields (Fig. 3) shows that the assumption $\varepsilon = 1$ increases the influence of turbulent heat transfer at small Re numbers but reduces it at high Re numbers. According to the Re number, $\varepsilon$ is thus higher or lower than 1.

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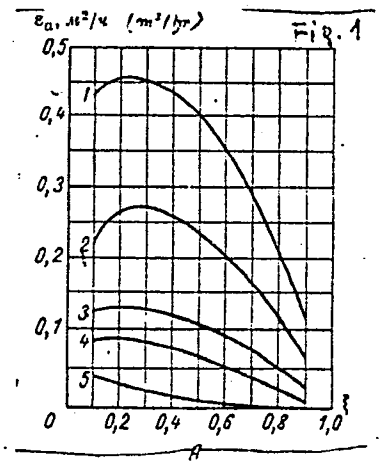
B102/B205

Turbulent heat...

Fig. 4 shows $\varepsilon = f(Re)$ at $\xi = 0.8$ for water (o), alkaline metal (o), and heavy metal (o). There are 4 figures.

SUBMITTED: July 14, 1960




Card 4/7

26368
S/089/61/011/002/004/015
B102/B201

21.5240

AUTHORS: Subbotin, V. I., Ibragimov, M. Kh., Ivanovskiy, M. N., Arnol'dov, M. N., Nomofilov, Ye. V.

TITLE: Heat transfer with a turbulent flow of liquid metals in tubes

PERIODICAL: Atomnaya energiya, v. 11, no. 2, 1961, 133-139

TEXT: This is a report on a study of heat transfer occurring with a turbulent flow of liquid alkali and heavy metals in tubes. In the range of $Pe = 10^2 \cdot 10^4$, experimental data on heat transfer to liquid metals differ considerably; they may, on the whole, be grouped into two classes which are characterized by $Nu = 7 + 0.025\,Pe^{0.5}$ (1) and $Nu = 3.3 + 0.014\,Pe^{0.8}$ (2). The authors determined the heat-transfer coefficients by two methods: by measuring the temperature field in the flow of liquid metal, and by measuring the wall temperature and the mean temperature of the liquid metal. Fig. 1 shows the experimental setup traversed by the metal vertically (from bottom to top). The characteristics of the experimental setup are as follows:

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B102/B201

Heat transfer with a turbulent ...

| | Part 1 | Part 2 |
|---|---|---|
| tube material | steel 1X18H9T (1Kh18N9T) | steel 1X18H9T (1Kh18N9T) |
| outer tube diameter | 42 mm | 34 mm |
| inner tube diameter | 31.1 mm | 29.3 mm |
| distance between tube inlet and thermocouple | 1166 mm | 985 mm |
| length of part with heat transfer | 1194 mm | 980 mm |
| distance between beginning of heated part and thermocouple | 976 mm | 945 mm |

All thermocouples (chromel-alumel couples) that served to measure the temperature of the liquid metal at the inlet and outlet of the test tubes, were calibrated on a platinum - platinum rhodium thermocouple. The electric power was measured by astatic wattmeters of accuracy index 0.2 and 0.5. The flow rate of the metal was measured by magnetic and throttle flow meters. The alkali metals were continuously purified from oxides (oxygen content 0.02-0.005% by weight), not so the heavy metals (oxygen content

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B102/B201

Heat transfer with a turbulent ...

$\sim 10^{-3}$% by weight). The temperature in the flow was measured with mobile thermocouples on 9-12 fixed points. Special small-size thermocouples served to measure the temperature fields; the results of these measurements were in good agreement with those calculated by Lyon's theory. The wall temperature was determined by extrapolation of the temperature profile for the wall. The mean temperature of the flowing liquid metal was calculated from the formula $\bar{t}_{liq} = \int_0^{r_0} Ut_{liq} rdr \Big/ \int_0^{r_0} Urdr$, where $U^+ = 5.5 + 2.5 \ln y^+$ was taken as the velocity-distribution law; ($y = 0.25$-$0.4$ mm). The Nusselt numbers resulting from the measurement of the temperature fields are in good agreement both with one another and with the results of other authors. They are consistent with Lyon's formula (1) in the range Pe = 100-12,000. It is not, however, as assumed by Lyon, $\varepsilon_a/\varepsilon_v = 1$ constant over the tube cross section, and independent of Pe, but radically variable, and smaller than unity for small Pe, larger than unity for large Pe. The second method takes account of the thermal contact resistance on the heat-transfer surface. The results obtained by the two methods are in

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X

S/862/62/002/000/010/029
A059/A126

AUTHORS: Zenkevich, B.A., Remizov, O.V., Subbotin, V.I., (Moscow)

TITLE: Influence of the channel geometry on critical thermal stresses in forced water flow

SOURCE: Teplo- i massoperenos. t. 2: Teplo- i massoperenos pri fazovykh i khimicheskikh prevrashcheniyakh. Ed. by A.V. Lykov and B.M. Smol'skiy. Minsk, Izd-vo AN BSSR, 1962. 106 - 111

TEXT: The behavior of corners formed by two adjacent ribs or a rib and the body of a fuel element in nuclear power reactors has been studied under the conditions of critical boiling. The determination of $q_{cr}$ was attempted a) in a tubular channel with an effective diameter of the shape of an isosceles triangle the sides at the top of which are conjugated by the total radius; a rounded-off plate has been welded to the corner-forming plates, and b) in a rectilinear channel with rounded-off corners. In both cases, the heated length was 200 mm, and $1/d_{equ}$ was about 42 in the former and about 24 in the latter case. Critical boiling occurred always at the top where water left the working section, and, in

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Influence of the channel geometry on critical thermal.. S/862/62/002/000/010/029 A059/A126

any case, at the corner. A Chromel-Alumel thermocouple has been used to establish the onset of critical boiling which worked in combination with a fast-electron potentiometer and has been welded to the outer triangular tubing at the corner (15°) or at one of the corners of the rectilinear tubing 4 to 5 mm below the upper feed line of flow. Experiments were performed on the critical thermal stresses at pressures between 60 and 170 at for the triangular and between 60 and 150 for the rectilinear tube. The velocity of water flow in both channels was about 1 to 6 m/sec, and underheating $\Delta t_s \simeq 2 - 50°C$. Experiments on the rectilinear channel were carried out at values of the conjugate radius R of 0.5 and 1.0 mm. No differences in $q_{cr}$ were found in the investigated range of parameters. From the data on the critical thermal stresses in circular tubes a considerable difference in $q_{cr}$ is established for the tubes compared at 60 at which decreases with increasing pressure, but increases with increasing velocity of water flow. Thermal stress decreases considerably in the presence of corners (15 and 90°) with radii of curvature of 0.5 to 1.00 mm at the corner of the fuel-element surface; the influence of the corners on $q_{cr}$ depends on the water flow. There are 1 figure and 2 tables.

Card 2/2

S/096/62/000/003/006/008
E195/E484

26.5200

AUTHORS: Subbotin, V.I., Doctor of Technical Sciences,
Ibragimov, M.Kh., Candidate of Technical Sciences,
Nomofilov, Ye.V., Engineer

TITLE: Measurement of turbulent temperature pulsations in a fluid stream

PERIODICAL: Teploenergetika, no.3, 1962, 64-67

TEXT: Experimental study of turbulent temperature pulsations provides a better understanding of the internal structure of the stream and the mechanism of heat transfer under turbulent flow conditions. The test fluids were water and liquid metal; the apparatus is described. The authors established that with a variation in the Reynolds number there was a change in the temperature profile and the amplitude of pulsations and that the characteristic of temperature pulsations, in the region of maximum amplitudes, was the same for both fluids tested, although their thermal conductivities differed by a factor of 20 or 30. There was also a noticeable difference between the

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distributions of pulsations along the pipe diameter for both liquid metal and water. In liquid metals, which have a fairly smooth change in temperature gradient over the pipe cross-section, maximum pulsations occurred halfway between the wall and pipe centre; whilst in water, which has a greater change in temperature gradient in the boundary region, maximum pulsations were observed in the immediate proximity of the pipe wall. When the Reynolds number was increased, the region of maximum pulsations was then displaced towards the wall, because the temperature profile in the fluid stream changed due to an increase in turbulent thermal conductivity. With a rise in Reynolds number, the shape of the temperature profile for liquid metal approached that for water. The authors introduce a new concept which they call "intensity of temperature pulsations" and which is expressed by the ratio of the rms amplitude to the temperature head. This expression changes over the cross-section of the pipe in the same manner as the rms value of the amplitude (Fig.2). With the increase in Reynolds number from $2 \times 10^4$ to $2 \times 10^5$ the intensity of temperature pulsations falls at all points in turbulent

Measurement of turbulent ... S/096/62/000/003/006/008
E195/E484

flow (Fig.3). Thus the maximum value of intensity of temperature pulsations must be in the Re region of 2300 to 20000, since pulsations do not occur in laminar flow. In addition to the temperature pulsations in the turbulent core of the stream, there are also pulsations in the immediate proximity of the wall, in the laminar layer and in the pipe wall itself. The variation in mean frequency of temperature pulsations, in fluid stream and pipe wall, with a change in Re number, is also given. There are 8 figures and 5 references: 4 Soviet-bloc and 1 Russian translation from non-Soviet-bloc publication.

Card 3/4

34663
S/096/62/000/004/001/001
E194/E455

26.5400

AUTHORS: Alekseyev, G.V., Engineer,
Zenkevich, B.A., Candidate of Technical Sciences,
Subbotin, V.I., Doctor of Technical Sciences, Professor

TITLE: An investigation of heat transfer when water in tubes boils with bubble formation

PERIODICAL: Teploenergetika, no.4, 1962, 74-76

TEXT: Although a good deal of experimental data has been accumulated on heat exchange when water boils in tubes, there are considerable differences between the results of various authors and little work has been done on heat transfer at high steam contents. The present work was undertaken to fill the gap. The experimental section consisted of a pure nickel tube of 12 mm o.d. with a wall thickness of 1.5 mm, electrically heated and with an effective length of 700 mm. The incoming water could be heated either to some definite temperature below the saturation temperature or to a given steam content. Tests were made with the pressure, the specific heat flow and the rate of flow of water (by weight) maintained constant, and the input heat

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S/096/62/000/004/001/001
E194/E455

An investigation of heat transfer ...

content of the water was determined which gave a set value of steam content in the experimental section. Tests were made with boiling with bubble formation at pressures of 30, 60, 100 and 150 atm with flow rates of 250 to 2000 kg/m$^2$ sec, with specific heat flow rates up to 0.6 x 10$^6$ kcal/m$^2$ hour and steam contents by weight up to 90%. The maximum error of determination of the steam content $\alpha$ ranged from ± 20% at a pressure of 30 atm to ± 50% at a pressure of 150 atm. The error rises with increase in pressure, because at higher pressures the temperature drops are smaller and the possibilities of error are greater. Forced flow was used and it was found that neither the rate of circulation nor the initial value of the steam content had any influence on the process of heat transfer and, with well-developed surface boiling, the heat transfer coefficient was entirely determined by the specific heat flux and the pressure. The influence of pressure on the heat-transfer coefficient can be allowed for by a criterion $K_p$. The following empirical formula was derived for heat transfer to a steam/water mixture during boiling with bubble formation:

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$$\alpha = 0.1 K_p^{0.314} q^{0.7} \qquad (4)$$

where

$$K_p = \frac{p \cdot 10^4}{\sqrt{\sigma(\gamma' - \gamma'')}} \qquad (5)$$

$\alpha$ - the heat transfer coefficient; q - the absolute pressure, $kg/cm^2$; $\sigma$ - the surface tension, kg/m; $\gamma'$, $\gamma''$ - the specific gravity of water and steam on the saturation line at the given pressure, $kg/m^3$. The maximum deviation of experimental points from this relationship does not exceed $\pm$ 30%. Results calculated by Eq.(4) are in good agreement with those found by other authors for the case of developed bubble type boiling in water initially below the saturation temperature. The relationship between the heat-transfer coefficient and pressure and specific heat flow is of the same form for boiling with developed bubbling in tubes as in bulk boiling. There are 7 figures.

SUBBOTIN, V.I.; IBRAGIMOV, M.Kh.; NOMOFILOV, Ye.V.

Heat transfer in the thermal stabilization region during turbulent flow of liquid metals in a tube. Atom. energ. 13 no.2:155-161 Ag '62. (MIRA 15:8)

(Hydrodynamics) (Heat—Transmission)

USHAKOV, P.A.; SUBBOTIN, V.I.; GABRIANOVICH, B.N.; TALANOV, V.D.; SVIRIDENKO, I.P.

Heat transfer and hydraulic resistance of close-packed bundles of rods arranged in-line. Atom. energ. 13 no.2:162-169 Ag '62. (MIRA 15:8)

(Heat--Transmission) (Nuclear reactors)

SUBBOTIN, V.I.; PAPOVYANTS, A.K.; KIRILLOV, P.L.; IVANOVSKIY, N.N.

Heat transfer to liquid sodium in pipes. Atom. energ. 13 no.4:380-382 O '62. (MIRA 15:9)
(Heat--Transmission) (Sodium)

ACCESSION NR: AP4004145 S/0294/63/001/002/0238/0246

AUTHORS: Subbotin, V. I.; Minashin, V. Ye.; Deniskin, Ye. I.

TITLE: Heat transfer in flow across banks of tubes

SOURCE: Teplofizika vy*sokikh temperatur, v. 1, no. 2, 1963, 238-246

TOPIC TAGS: heat transfer, liquid metal, transverse flow, reactor coolant, heat exchanger, coolant, thermal conductivity

ABSTRACT: A brief review is presented of heat exchange research on transverse flow of water and liquid metal over bundles of tubes, carried out at the Fiziko-energeticheskiy institut (Physics and Power Engineering Institute) in 1958--1962. The measurement procedures are briefly described. The results are summarized as follows: 1. The wall temperature of the heat-releasing tube varies with time and the temperature pulsations are due to instability of liquid flow. 2. The average heat transfer coefficient for pure liquid metals can be calculated accurate to ±30%, for a wide range of different tube-bundle geometries, from the formula $Nu = Pe^{0.5}$ (Pe = 150--7,000), where the average velocity is calculated in the narrow sec-

ACCESSION NR: AP4004145

tion of the bundle, and the linear dimension is chosen to be the tube diameter. 3. The relative temperature profile varies little over the perimeter of the tube with variation of the bundle geometry and rate of coolant flow. 4. The wall temperature pulsations are assumed to be due to instability of some layer next to the wall. 5. The temperature pulsations depend strongly on the bundle geometry. 6. The relative pulsations depend little on the velocity. It is therefore recommended that until more detailed research is made each individual bundle be characterized by the maximum temperature pulsation. 7. The temperature pulsations depend linearly on the heat flow when the physical properties change little. 8. The temperature pulsation frequency increases with increasing velocity and ranges from 0.01 to 5 cps. 9. Below 0.5 or 1 cps the temperature pulsations depend little on the tube material and vary little over the thickness (2 mm). 10. Insulating films affect temperature pulsations with frequencies lower than 0.5 cps little, and the temperature gradient changes in this case by a factor 2--3. 11. The character of the temperature pulsations depends strongly on the bundle

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ACCESSION NR: AP4004145

geometry and on the velocity. 12. The absolute values of the temperature pulsations are nearly the same for flow of water or liquid metal. Orig. art. has: 6 figures, 4 formulas, and 1 table.

ASSOCIATION: Fiziki-energeticheskiy institut (Physics and Power Engineering Institute)

SUBMITTED: 11Jun63 DATE ACQ: 26Dec63 ENCL: 00

SUB CODE: PR, AI NO REF SOV: 013 OTHER: 009